Optional ERIC Coversheet — Only for Use with U.S. Department of Education Grantee Submissions

This coversheet should be completed by grantees and added to the PDF of your submission if the information required in this form **is not included on the PDF to be submitted**.

INSTRUCTIONS

- Before beginning submission process, download this PDF coversheet if you will need to provide information not on the PDF.
- Fill in all fields—information in this form **must match** the information on the submitted PDF and add missing information.
- Attach completed coversheet to the PDF you will upload to ERIC [use Adobe Acrobat or other program to combine PDF files]—do not upload the coversheet as a separate document.
- Begin completing submission form at https://eric.ed.gov/submit/ and upload the full-text PDF with attached coversheet when indicated. Your full-text PDF will display in ERIC after the 12-month embargo period.

GRANTEE SUBMISSION REQUIRED FIELDS

Title of article, paper, or other content

Examining the Relationship Between 2-year College Entry and Baccalaureate Aspirants' Academic and Labor Ma

All author name(s) and affiliations on PDF. If more than 6 names, ERIC will complete the list from the submitted PDF.

Last Name, First Name	Academic/Organizational Affiliation	ORCID ID
Di Xu	University of California - Irvine	
Sabrina Solanki	University of California - Irvine	
Ashley Harlow	University of California - Irvine	

Publication/Completion Date—(if *In Press,* enter year accepted or completed) May 2019

Check type of content being submitted and complete one of the following in the box below:

- ☑ If article: Name of journal, volume, and issue number if available
- ☐ If paper: Name of conference, date of conference, and place of conference
- ☐ If book chapter: Title of book, page range, publisher name and location
- ☐ If book: Publisher name and location
- ☐ If dissertation: Name of institution, type of degree, and department granting degree

Research in Higher Education. 61:297 - 329.

DOI or URL to published work (if available) https://doi.org/10.1007/s11162-019-09559-7

Acknowledgement of Funding— Grantees should check with their grant officer for the preferred wording to acknowledge funding. If the grant officer does not have a preference, grantees can use this suggested wording (adjust wording if multiple grants are to be acknowledged). Fill in Department of Education funding office, grant number, and name of grant recipient institution or organization.

"This work was supported by U.S. Department of Education **[Office name]** Institute of Education Scie through **[Grant number]** R305B1700 to **Institution]** University of M. The opinions expressed are those of the authors and do not represent views of the **[Office name]** Institute of Education Scie or the U.S. Department of Education.

Research in Higher Education (2020) 61:297–329
https://doi.org/10.1007/s11162-019-09559-7

Examining the Relationship Between 2-year College Entry and Baccalaureate Aspirants' Academic and Labor Market Outcomes: Impacts, Heterogeneity, and Mechanisms

Di Xu[1] · Sabrina Solanki[1] · Ashley Harlow[1]

Received: 3 July 2018 / Published online: 9 May 2019

Abstract
Using the Education Longitudinal Study of 2002 (ELS:2002), this paper analyzes students' baccalaureate attainment and early labor market performance, comparing 2-year college and 4-year institution entrants and exploring the potential heterogeneous treatment effects of initiating one's college experience in a 2-year college by individual pre-college academic preparation. Utilizing propensity score matching on a rich set of student demographic characteristics, academic and high school attributes, we find that 2-year college entry sharply reduces baccalaureate aspirants' likelihood of earning a baccalaureate, and such negative effects are particularly pronounced for students in the highest quartile of pre-college math ability. In terms of labor market outcomes, female 2-year college entrants are less likely to gain full-time employment, as compared to their female 4-year institution counterparts. We also examine various mechanisms that may hinder 2-year college entrants' baccalaureate completion, including the impact of 2-year college attendance on early academic progress, challenges of the transfer process, loss of credits at the point of transfer, and post-transfer academic shock. Our results provide suggestive evidence in support of all four mechanisms.

Keywords Vertical transfer · Propensity score matching · Labor market outcomes · Heterogeneous impacts · Mechanisms

✉ Di Xu
dix3@uci.edu

Sabrina Solanki
ssolanki@uci.edu

Ashley Harlow
aharlow@uci.edu

[1] School of Education, University of California, Irvine, 3200 Education Bldg, Irvine, CA 92697, USA

Introduction

One of the most important functions of open-access 2-year public institutions is serving as a stepping stone to a baccalaureate at a 4-year institution. Indeed, according to a recent report, 80% of students enrolled at a 2-year college intend to earn a baccalaureate (Jenkins and Fink 2016). A number of studies have examined the impact of initiating one's higher education experience at a 2-year college on academic outcomes, generally identifying a negative association between 2-year college entry and probability of obtaining a baccalaureate even among students with a clear intent to earn a baccalaureate (e.g., Alfonso 2006; Long and Kurlaender 2009; Monaghan and Attewell 2015; Brown and Xia 2014). There are relatively fewer studies, however, that examine student labor market outcomes; thus, researchers have not agreed upon whether—and, when applicable, to what extent—the negative impact of initiating one's education at a 2-year college on student educational outcomes may translate to reduced labor market opportunities.

Drawing on the Education Longitudinal Study of 2002 (ELS 2002), this study contributes to the transfer literature in three main ways. First, we examine the impact of initiating at a 2-year college on baccalaureate aspirants' academic and labor market outcomes. Understanding the labor market impacts of 2-year college entry is critical; from a policy perspective, comparing the relative labor market outcomes of initiating at 2-year and 4-year institutions can inform the current expansion of 2-year colleges. In particular, policymakers extolling 2-year colleges as a cost-saving pathway to baccalaureate attainment need to understand the relative cost and benefit of initiating at 2-year colleges. From the student's perspective, while 2-year colleges are often viewed as a more affordable way to pursue a baccalaureate, students should be equipped with a comprehensive understanding about how initiating their education at a 2-year college may influence their probability of attaining a baccalaureate and labor market opportunities.

In addition, we also assess the potential heterogeneous treatment effects of initiating at a 2-year college according to individual pre-college academic preparation. Much of the transfer debate that attempts to understand the impacts of 2-year college attendance typically focuses on the often-analyzed but still poorly-understood "average" effects for 2-year college entrants. Few studies have analyzed the extent to which initiating at a 2-year college may have heterogeneous effects on different groups of students, benefiting some students while disadvantaging others—or, at least, disadvantaging students to a different extent. Given the vast compositional heterogeneity of the undergraduate student population, there is little reason to believe that the treatment effects of initiating at a 2-year college are the same for all students (Brand et al. 2012; Brand and Xie 2010). Indeed, using a propensity score matching strategy to allow comparisons between similar baccalaureate-seekers entering 2-year colleges and those entering 4-year institutions, we found that while 2-year college entry sharply reduces baccalaureate aspirants' likelihood of earning a degree, such negative effects are particularly pronounced for students who are in relatively higher quartiles of pre-college math ability.

Finally, we also examine four potential mechanisms that may contribute to lower baccalaureate completion rates for 2-year college entrants, including the impact of 2-year college attendance on early academic progress, challenges of the transfer process, loss of credits at the point of transfer, and post-transfer academic shock. While many studies have compared 2-year college and 4-year institution entrants in terms of educational attainment (e.g., Alfonso 2006; Anderson 1981; Brand et al. 2012; Doyle 2009; Leigh and Gill 2003; Miller 2007; Rouse 1995; Stephan et al. 2009; Velez 1985; Wang et al. 2015), there is a general

lack of consensus about the mechanisms through which the impacts of 2-year college attendance may unfold. Understanding the potential reasons why baccalaureate aspirants may fare more poorly if they choose to enter a 2-year college instead of a 4-year institution appears critical for addressing social inequality, as more informed policies on vertical transfer may help to reduce disparities in college outcomes and, in turn, promote improved life prospects.

Literature Review

The Differing Profiles of Baccalaureate Seekers Who Enter 2-year Versus 4-year Colleges

Previous research suggests that the population of students who attend 2-year colleges are markedly different than those who attend 4-year institutions. For example, among students initiating their college experience at 2-year institutions, 51.5% are Hispanic and 52.4% are Black whereas these percentages are 30.3% and 34.1% respectively at 4-year institutions (Berkner and Choy 2008; National Center for Public Policy and Higher Education 2011). Monaghan and Attewell (2015) also found that only one-third of 2-year college entrants had parents who went to college compared to half of 4-year college entrants, indicating that 2-year college entrants are more likely to be first-generation students. Lastly, existing evidence suggests that students who begin their college experience at 2-year institutions often come from low-socioeconomic backgrounds as compared to students who begin at 4-year institutions (Brint 2003). This may partially be due to the relative bargain of attending a 2-year college: the College Board reports that the average annual cost of tuition and fees for in-state students to attend a public 2-year college is $3440, compared with $9410 for public 4-year institutions.[1]

Research also suggests that 2-year college entrants are on average less academically prepared compared to 4-year college entrants. For example, students who initiate their college experience at a 2-year institution are more likely to have lower high school math and reading performance (Alfonso 2006). In addition, probably as a result of 2-year colleges' open admissions policies and flexible scheduling options, non-traditional students—married students, students with dependents, older students—are more likely to attend 2-year institutions than traditional students (Ohio et al. 2009; Alfonso 2006). These baseline differences in background characteristics of baccalaureate seekers entering 2-year versus 4-year colleges highlight the importance of creating more comparability between the two groups in any analysis that aims to understand how initial enrollment in the 2-year sector may influence students' academic and labor market outcomes.

Impact of Initiating in the 2-Year Sector on Academic and Labor Market Outcomes

Descriptively, 2-year college entrants have been found to have substantially lower baccalaureate completion rates than students who begin their college career at a 4-year institution. In a recent study conducted by the National Student Clearinghouse, only

[1] Information retrieved from https://bigfuture.collegeboard.org/pay-for-college/college-costs/college-costs-faqs.

13% of 2-year college entrants received a baccalaureate in a six-year period between 2010 and 2016 (Shapiro et al. 2017). This is an extremely low figure considering that 80% of students enrolled at 2-year colleges intend to earn a baccalaureate (Jenkins and Fink 2015).

Lower baccalaureate attainment rates for 2-year entrants may be partly due to differences between baseline characteristics of 2-year and 4-year institution student populations. However, even after adjusting for these differences, existing studies on vertical transfer consistently identified a negative association between 2-year college entrance and baccalaureate attainment (Alfonso 2006; Anderson 1981; Doyle 2009; Leigh and Gill 2003; Miller 2007; Kane and Rouse 1995; Stephan et al. 2009; Velez 1985; Long and Kurlaender 2009; Monaghan and Attewell 2015; Reynolds 2012). Using data from the National Education Longitudinal Study (NELS), Reynolds (2012) restricted the analytic sample to only baccalaureate seekers at less-selective colleges, and used propensity score matching strategy to identify 4-year institution entrants who resemble 2-year college entrants in both academic and demographic characteristics. He found that the percentage of 2-year college entrants who earned a baccalaureate within approximately 8 years was nearly 25 points lower than the percentage of 4-year institution entrants who received the same degree. Using similar restrictions and methodological approach, Monaghan and Attewell (2015) drew upon the Beginning Postsecondary Students (BPS) survey and found that 2-year college entrants' six-year baccalaureate attainment rates were approximately 17 percentage points lower than those of similar 4-year institution entrants. Long and Kurlaender (2009) also used a propensity score matching strategy and found that 2-year college entrants' 9-year baccalaureate attainment rates were 21 points lower. To address potential concerns associated with unobserved baseline differences, Long and Kurlaender (2009) further employed an instrumental variable (IV) approach, using the distance between a student's home and both the nearest 2-year and 4-year institution as instruments to predict enrollment at either institution. The IV approach still yielded a significant negative coefficient, though the effect size was slightly smaller.

A handful of studies have also examined the impacts of 2-year college entrance on students' labor market outcome and the results are rather mixed (Hilmer 2000; Leigh and Gill 2003; Light and Strayer 2004; Miller 2007; Reynolds 2012; Brown and Xia 2014). For example, using propensity score matching, Reynolds (2012) provided evidence that 2-year college attendance was associated with only small declines in labor market returns that were primarily driven by female entrants. In contrast, using an administrative dataset from Texas with an IV approach, Miller (2007) found a strong labor market penalty ($1449 per quarter) for 2-year college entrants.

Other studies examining labor market impacts of initially enrolling at a 2-year college have limited their focus to students who have ever transferred to—or graduated from—a 4-year institution (Hilmer 2000; Leigh and Gill 2003; Light and Strayer 2004; Miller 2007; Xu et al. 2018). For example, a recent study used propensity score matching to compare vertical transfers and similar native 4-year institution students attending the same 4-year institution in the state of Virginia (Xu et al. 2018). The results suggest that while vertical transfer students' probability of baccalaureate attainment was comparable to that of similar native 4-year institution students, transfer students were subject to a significant and non-trivial earnings penalty 8 years after initial college enrollment. Drawing upon subsequent analyses of student transcript data, the authors indicated that this earnings decrement might be partly due to delayed entry into the labor market as a result of credit loss at the point of transfer.

Heterogeneous Impact of Initiating at a 2-Year College by Student Characteristics

The majority of studies reviewed above focus exclusively on generating an average estimate for how initiating at a 2-year college, as opposed to a 4-year institution, may influence a student's academic and labor market outcomes. However, researchers have recently challenged this emphasis on average effects, arguing that the effect of attending a 2-year college may differ according to the "counterfactual" educational pathway and associated outcomes (Brand 2010; Brand et al. 2012; Brand and Xie 2010). For example, the counterfactual for academically advantaged 2-year attendants could be selective 4-year attendance and degrees, while the most likely counterfactual for many disadvantaged students is no postsecondary credential at all. As a result, initiating at a 2-year college may disadvantage some students while benefiting others.

Indeed, using data on the postsecondary outcomes of high school graduates from Chicago Public Schools and a propensity score matching strategy with four different counterfactual conditions—no college at all, non-selective 4-year institutions, selective 4-year institutions, and highly selective 4-year institutions—Brand et al. (2012) found that initiating one's college experience at a 2-year college has the largest penalty for academically advantaged students who would otherwise have attended 4-year schools, especially highly selective 4-year institutions. This finding provides suggestive evidence that the effects of the 2-year college pathway to attain a baccalaureate may indeed differ based on student characteristics. Further, students with higher level of academic potential may experience the largest penalty from the "diversionary effect" of 2-year college entrance, which suggests that the educational outcomes of potential 4-year institution attendees may be negatively impacted by their learning experiences at 2-year colleges (e.g., Brand et al. 2012; Leigh and Gill 2003; Rouse 1995). This is in line with Burton Clark's (1960) description of a "cooling out" process at 2-year colleges, in which academic setbacks encountered by the student in college serve to gradually diminish their degree aspirations. The cooling out function of 2-year colleges was further elaborated by Dougherty (1994) who pointed out that the emphasis on vocational training at 2-year colleges may undermine students' aspiration to transfer.

In a similar vein, the heterogeneous effects of 2-year college entrance regarding students' degree attainment may translate into differential impacts for students' subsequent labor market outcomes. Given the strong correlation between the quality of institution from which a student receives a baccalaureate and students' labor market outcomes, the Brand et al. (2012) findings imply that academically advantaged 2-year college entrants may also be penalized in terms of labor market performance. However, no studies thus far have examined possible heterogeneity in the effects of initiating at a 2-year college in regard to labor market outcomes.

Potential Mechanisms for Disparity

Why do baccalaureate aspirants fare more poorly if they choose to enter a 2-year college instead of a 4-year institution? Of the studies concluding that 2-year college entrants are less likely than 4-year institution entrants to earn a baccalaureate, many contend that 2-year colleges have a negative impact on students' early academic progress (e.g., Leigh and Gill 2003; Rouse 1995). Indeed, compared to 4-year institutions, 2-year colleges offer fewer student support services (Desrochers and Hurlburt 2014), and very few offer the option of

on-campus residence, both factors of which are thought to be critical for college integration and persistence (Choy and Gifford 1990; Pascarella and Terenzini 1991; Tinto 1975, 1987). In addition, potential 4-year institution students who choose to enter the 2-year college sector can be forced to fulfill various remedial requirements. For example, both Long and Kurlaender (2009) and Monaghan and Attewell (2015) indicated that the very high rate of math remediation for 2-year college students seems quite incongruous with the small difference in academic preparation between matched 2-year college and 4-year institution students. The existing literature on developmental education has failed to find consistent evidence concerning the benefits of receiving college remediation (Calcagno and Long 2008; Martorell and McFarlin 2011; Scott-Clayton and Rodriguez 2015; Xu 2016; Xu and Dadgar 2018). On the contrary, a number of recent studies indicate that the assignment of developmental coursework may negatively influence student college persistence (Xu 2016; Xu and Dadgar 2018) and that developmental education may divert students from college-level coursework, resulting in fewer college-level credits earned (Scott-Clayton and Rodriguez 2015).

As a second point, students may have difficulty navigating the challenges inherent in selecting and enrolling at a 4-year transfer destination. Each 4-year institution system typically has a distinct application and financial aid process; as a result, students need to manage their transfer applications for each destination institution separately. This is further complicated by the lack of articulation agreement between 2-year colleges and 4-year institutions, resulting in a general lack of awareness regarding the specific courses required for transfer to a 4-year institution and therefore selection of suboptimal courses (Baker 2016; Hull 2018; Jaggars and Fletcher 2014). While academic advising is available at 2-year colleges, the typical student-to-advisor ratio is approximately 1000:1 due to financial constraints (Gallagher 2010; Grubb 2006; Rosenbaum et al. 2006), and to complicate matters further, advisors are often knowledgeable about only one or two popular transfer destinations.

At one large comprehensive community college, students find the process of selecting and transferring to a 4-year institution an especially bewildering and frustrating one. One student complains:

> "They [academic advisors] basically only know [the top two transfer schools] because they have the best relationship with them; but other than that, you're more or less just on your own. And that's where a lot of us go through word-of-mouth or people that we know, because there really is no clarification or reassurance in the website or just in [the community college's] people in general."

Similar student complaints about the transfer process are well-documented in a variety of qualitative studies (Jaggars and Fletcher 2014; Kadlec and Gupta 2014; Kadlec and Martinez 2013; Public Agenda 2012). Given the logistical work required to navigate the vertical transfer process and a lack of structure, standardization, and support mechanisms that could help students contend with the complex process, it is unsurprising that many academically successful 2-year college students opt not to transfer and therefore not to earn a baccalaureate (Monaghan and Attewell 2015).

Third, although many states have policies requiring public 4-year institutions to accept an agreed-upon set of credits from 2-year colleges, most agreements do not guarantee that these credits will apply to students' intended majors. As a result, one key barrier to success for vertical transfer students who eventually enroll at a 4-year institution is either a loss of credits at the time of transfer or requirements prompting the acquisition of unnecessary credits. For example, using college administrative data from the state of Virginia, Xu et al.

(2018) found that among students who received a baccalaureate, vertical transfer students earned 10 more credits than their 4-year institution peers—and 16 more credits than should be necessary for a traditional 4-year degree—providing evidence supporting either loss of credits during the transfer process or a requirement to take unnecessary classes that results in extra credits obtained.

Finally, for students who successfully navigate the transfer process, there are concerns that they may be subject to transfer shock, or the drastic difference in cultural and/or academic expectations between a student's attended institutions (Hills 1965). While studies suggest that a promising way to encourage transfer student persistence is with faculty mentorship and support (Jackson and Laanan 2015; Lundberg et al. 2018; Lee and Schneider 2016), qualitative studies have generally found that 4-year institutions do not provide enough academic support for incoming transfer students (Townsend and Wilson 2006; Flaga 2006). A lack of support and structure therefore perpetuates costly mistakes, confusion, and disengagement for transfer students (Kadlec and Gupta 2014). This can help to explain why many vertical transfer students' GPAs are impacted negatively during their first term at the 4-year institution (Domingo and Nouri 2016; Bahr et al. 2013; Lakin and Elliot 2016; Xu et al. 2018). However, the GPA dip identified in these studies appears to be temporary, as it partially rebounded after the initial term, suggesting that the dip may be driven mainly by transfer students' social and logistical adjustment to the new institution's environment.

The Current Study

As calls to improve higher education efficiency continue to grow louder, it becomes increasingly urgent to understand how the 2-year college pathway may influence baccalaureate-seeking students' outcomes. In this paper, we examine how the 2-year college pathway to a baccalaureate influences students' degree attainment and short-term labor market performance, as well as examine various mechanisms through which the effects may unfold: diversion, logistic challenges of transfer, credit loss, and transfer shock. Specifically, we ask three research questions:

1. Do baccalaureate attainment and labor market outcomes differ for baccalaureate aspirants who initiate their college experience at a 2-year college as compared to similar students who initiate at a 4-year institution?
2. Is the relationship between 2-year college entry and academic and labor market outcomes different by students' pre-college academic ability?
3. What mechanisms may stand in the way of baccalaureate completion among 2-year college baccalaureate aspirants?

Data and Methods

Data and Measures

This study uses the Education Longitudinal Study of 2002 (ELS 2002) dataset. The ELS:2002 is a nationally representative study of students in 10th grade in 2002 and 12th grade in 2004. The study generated six waves of data that cover transcripts from both high school and postsecondary education and student earnings records in 2011, which provide

a follow-up 7 years after college enrollment. The dataset also includes a rich set of variables which we include in our regression analyses. Below we describe our key variable of interest (i.e., whether a student started at a 2-year or a 4-year institution), variables we use as covariates to create more comparability between the 2-year and 4-year entrants, and the key outcome measures.

Initiating at a 2-Year College

The key independent variable of interest in our analyses is whether students initiated their college experience in a 2-year or 4-year institution. To define a student as either a 2-year college or 4-year institution entrant, we use a variable in the ESL:2002 dataset that indicates the first post-secondary institution attended by a student following high school. Students who initiated at a public or private not-for-profit 2-year college are categorized as 2-year college entrants, and students who initiated their college experience at a public or private not-for-profit 4-year institution are categorized as 4-year institution entrants.[2]

In order to create more comparability between the 2-year and 4-year entrants, we include in our model three sets of covariates, including student demographic characteristics, pre-college academic achievement, and the attributes of a student's high school.

Student Demographic Characteristics

As mentioned in Sect. 2.1, 2-year and 4-year entrants differ from each other in demographic attributes which may also be correlated with student degree outcomes. We therefore include in our models indicators for student gender and race, and an SES composite variable. The SES composite is from the base-year survey and includes five equally weighted standardized components: father education, mother education, family income, father occupation, and mother occupation.[3]

Pre-college Academic Preparation Variables

Pre-college academic preparation variables are also included to address differential levels of academic preparation between 2-year and 4-year entrants. Specifically, we include math and verbal test scores from 12th grade and high school GPA to measure student academic performance prior to college enrollment. We further include total vocational units taken during high school to address the concern that students interested in taking more vocational units may choose a different academic pathway that is also associated with subsequent degree and labor market outcomes.

[2] It is worth noting that 12% of the college-going students in the ELS:2002 data started taking courses at either a 2-year or 4-year institution through dual enrollment while they were still enrolled in high school. As a robustness check, we include these students in the analytical sample and run all main analyses. We include the results in Appendix Table 10. As shown in Appendix Table 10, results remain consistent with this sample.

[3] The majority of the control variables have a missing rate below 6%. We use a dummy variable adjustment to missing data, which is a commonly used approach (Allison 2002). More specifically, we plug in a value for missing data, typically 0 for dichotomous variables or the variable's mean if the variable is continuous. We then include in the regression a dummy variable coded as 1 if data in the original variable was missing and 0 otherwise.

High-School Characteristics

We also include measures for the characteristics of a student's high school—total high school enrollment, percentage of student enrollment with free lunch status, teacher salary, and the geographic location of the school—to address the possibility that these school-level attributes may influence both students' college choice and subsequent academic and labor market outcomes.

In this study, we focus on a number of academic and labor market outcomes. Specifically, we examine the relationship between initiating at a 2-year college and a 4-year institution in regard to the following outcome measures:

Baccalaureate completion information was extrapolated from student college transcript data. The data includes a variable that indicates the highest known degree the student received from any postsecondary institution. We use degree status measured at the end of 2010, a 6-year window, as the majority of the students in our sample initiated their college experience in 2004. Students who earned a baccalaureate or a higher-level degree by the end of 2010 were coded as 1, and all others were coded as 0.[4]

Employment was generated from a variable in the third follow-up survey in 2012 that characterizes student employment status (full-time or part-time) during the calendar year of 2012, or 8 years since initial college enrollment. Individuals designated as "out of the labor force" were dropped from the analysis. Among those who were in the labor force, students designated as working full-time were coded as 1, whereas students working either part-time or designated as "unemployed" were coded as 0. To further differentiate between full-time and part-time employment status, we also created a separate outcome variable conditional on being employed where full-time employment is coded as 1 and part-time employment status is coded as 0.

Annual earnings. In the third follow-up survey in 2012, respondents were also asked to report their annual earnings during the calendar year of 2011, or 7 years after students' initial enrollment in college. We include the natural log of earnings as our outcome measure; students with no earnings were automatically dropped from the analysis.

Sample and Summary Statistics

As outlined above, we focus our analysis on students enrolled at public and not-for-profit private colleges. Considering that 2-year colleges address a broad range of student needs in addition to facilitating baccalaureate attainment, we restricted our sample to students who indicated an intent to receive a baccalaureate in the baseline survey, administered while they were in high school. In addition, while the majority of the students in the ELS dataset began their college career right after high school (i.e., enrolling in college during the summer of 2004, fall of 2004, or spring of 2005), 11% delayed college entry until after spring 2005, which would lead to a shorter follow-up window for labor market performance. We therefore excluded these students from our analyses. Our analytical sample includes a total of 6,830 students, where approximately one quarter initially enrolled at a 2-year college.

[4] In a separate robustness check, we also extend the follow-up window to 2013, or 9 years post initial college enrollment, and the estimated baccalaureate attainment gaps between 2-year and 4-year college entrants remain fairly similar.

Table 1 Summary statistics of the analytical sample

	2-year college entrants	4-year institution entrants
	(1)	(2)
Demographic		
Male	0.457	0.446
White	0.564	0.658
Black	0.128	0.103
Hispanic	0.155	0.077
Asian	0.104	0.115
Other	0.049	0.047
Academic preparation		
Standardized reading score G12	−0.068	0.597
Standardized math score G12	−0.211	0.613
HSGPA (all courses)	2.693	3.183
Vocational units	3.256	2.304
Socio-economic status		
SES composite: first-quartile (Q1)	0.212	0.099
SES composite: second-quartile (Q2)	0.259	0.162
SES composite: third-quartile (Q3)	0.285	0.260
SES composite: fourth-quartile (Q4)	0.245	0.478
High school		
HS enrollment	1.330	1.210
HS program: general	0.356	0.219
HS program: college preparatory	0.566	0.740
HS program: vocational	0.078	0.041
HS: percent free lunch	0.248	0.215
HS: teacher pay (1000 s)	42.43	42.01
HS type: urban	0.287	0.377
HS type: suburban	0.525	0.475
HS type: rural	0.188	0.147
N	1750	5080

Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

HS high school

Table 1 presents the summary statistics for the 2-year and 4-year enrollees in the analytical sample. The descriptive statistics in Table 1 indicate that the 2-year and 4-year college enrollees are substantially different. For example, a larger proportion of underrepresented racial and ethnic minority (URM) students initiated at a 2-year than at a 4-year institution. Additionally, 2-year colleges enrolled a larger proportion of students with lower academic ability, as measured by verbal and math standardized test scores and high school GPA. Lastly, about a quarter of students from each SES-composite quartile attended a 2-year college, whereas 4-year institutions largely enrolled students from the top two SES-composite quartiles.

Table 2 Average outcomes for 2-year and 4-year college entrants

	Full sample		Male sample		Female sample	
	2-year	4-year	2-year	4-year	2-year	4-year
	(1)	(2)	(3)	(4)	(5)	(6)
Received baccalaureate or higher	0.198	0.664	0.202	0.636	0.194	0.687
ln(earnings)	9.870	10.13	10.08	10.21	9.696	10.07
Employed full-time (vs. PT or unemployed)	0.758	0.816	0.796	0.834	0.727	0.802
Full-time conditional employment (vs. PT)	0.832	0.875	0.857	0.894	0.811	0.860

Table 2 presents summary information regarding our key outcome measures, by 2-year and 4-year entrants respectively. On a descriptive basis, there is a large degree attainment gap between baccalaureate aspirants who initiated at a 2-year college and those who initiated at a 4-year institution. Similarly, we also find an employment and earnings gap favoring students who initiated at a 4-year institution. These gaps in degree attainment and labor market outcomes are present in both the male and female sub-samples.

Estimation Strategy

To assess the impact of initiating at a 2-year college on academic and labor market outcomes, the basic strategy, modeled in Eq. (1), relates student *i*'s outcomes Y to the type of institution that the student initially enrolled at.[5]

$$Y_i = \alpha + \beta\, \text{Twoyear}_i + X_i + \mu_i \quad (1)$$

The key explanatory variable is whether the student initiated at a 2-year college. The model also incorporates a rich set of controls, denoted by X_i and shown in Table 1, that include student demographic characteristics, academic preparedness, and high school attributes.[6]

Following the transfer literature, we used a propensity score matching strategy to simulate a comparison group of native 4-year institution students that resembled our sample of 2-year college entrants (Long and Kurlaender 2009; Monaghan and Attewell 2015; Reynolds 2012; Xu et al. 2018). The propensity score strategy has two major advantages over ordinary least squares (OLS) regression in the current research scenario. Methodologically, propensity matching can avoid data extrapolation by making inferences only from data on students who are similar regarding observed characteristics. Practically, this estimate

[5] For all models where the outcome variable is a labor market measure, we include the regional unemployment rate as an additional control variable. We retrieved information about where each respondent lived in 2012, when employment status was measured. Specifically, this information included the census region where the respondent lived (i.e., northeast, midwest, south, and west). In our analyses, we use the seasonal unemployment rate for each region retrieved from the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS).

[6] We include in all models a "first-term" fixed effects which is a set of control variables that indicate the specific time when a student first entered college (e.g., fall 2004). We include this variable to account for unobserved heterogeneity that arise from students starting college at different points in time, such as an economic shock that happened during a certain time that may influence both students' college choice and subsequent academic outcomes.

directly addresses the policy concern of using 2-year colleges as a pathway to baccalaureate attainment by focusing on the types of baccalaureate-aspiring students who are most likely to take the 2-year college route.

The propensity score matching estimation was obtained using a three-step process. First, we estimated a student's propensity of initiating at a 2-year college given his/her observable characteristics using a logit model:

$$\text{logit}\left(\text{Twoyear}_i\right) = \alpha + \text{X}_i + \mu_i \tag{2}$$

where Twoyear_i is the key variable of interest for student i and is equal to 1 if the student initiated at a 2-year college. Based on Eq. (2), we predicted the probability of initiating at a 2-year college for each student in our analytical sample.

Second, we used the estimated propensity scores to match each 2-year college entrant with a 4-year institution entrant based on the nearest-neighbor method with a caliper of 0.01 with replacement (Dehejia and Wahba 2002).[7] As a result, 2-year college entrants who had no match within 0.01 standard deviations of the propensity score in the 4-year college entrants group were dropped from the analysis (this only applies to less than 1% of the 2-year sample). Accordingly, the post-match sample consists of only baccalaureate aspirants who are at least somewhat likely to consider the 2-year college pathway to a baccalaureate. In the third and final step of the analysis, we used Eq. (1) to estimate the association between 2-year college entry and student outcomes using the post-match sample (Abadie et al. 2002; Hill 2008; Rosenbaum and Rubin 1985; Rubin and Thomas 2000).[8]

Table 3 presents the results from the model, based on Eq. (2), which predicts students' probability of initiating at a 2-year college instead of a 4-year institution. For easier interpretation, we converted all the log odds into marginal effects. As expected, a number of pre-college academic variables are highly predictive of 2-year college entry. For example, 2-year college entrants were more likely to earn lower high school grades, to accumulate vocational units, and to report lower math and verbal test scores than 4-year institution entrants. Specifically, a one standard deviation increase in high school GPA is associated with a decreased probability that students would attend a 2-year college by roughly twelve percentage points. A one standard deviation increase in vocational units is associated with an increased probability that students would attend a 2-year college by three percentage points. A one standard deviation increase in math score is associated with a reduced probability that students would attend a 2-year college by seven percentage points. In addition to these academic preparation variables, socio-economic status is also highly predictive of 2-year college attendance in our sample.

The left panel in Fig. 1a presents the distributions of the predicted propensity of initiating at a 2-year college for 2-year and 4-year institution entrants respectively. The distribution clearly shows the presence of differential sorting into 2- and 4-year institutions. Specifically, the majority of 2-year college entrants had a high probability of choosing the 2-year college pathway: almost half had a probability equal to 0.50 or higher, and a fifth had a probability of 0.75 or higher. On the other hand, the majority of 4-year institution entrants

[7] We use psmatch2 software for Stata by Leuven and Sianesi (2003) to implement the propensity score matching procedure. For all analyses by gender subgroup, the matching procedure is conducted for male and female students separately.

[8] Specifically, we run a regression of outcome on the treatment indicator and confounding covariates (Eq. 1) using weights (generated by using psmatch2) to force the sample to represent matched groups (1 if in treatment group, 0 if not matched, and # times matched for matched controls).

Table 3 Probability of attending a 2-year college among baccalaureate-seeking students (logit model with marginal effects reported)

	Full sample	Male sample	Female sample
Male	−0.001	–	–
	(0.011)	–	–
Black	−0.106***	−0.111***	−0.107***
	(0.013)	(0.019)	(0.018)
Hispanic	0.010	0.022	−0.000
	(0.020)	(0.031)	(0.026)
Asian	−0.028	−0.054**	−0.009
	(0.018)	(0.025)	(0.027)
Other	−0.045**	0.004	−0.081***
	(0.021)	(0.038)	(0.025)
Reading score G12 (Std)	−0.037***	−0.030***	−0.046***
	(0.008)	(0.011)	(0.011)
Math score G12 (Std)	−0.074***	−0.074***	−0.072***
	(0.008)	(0.011)	(0.012)
HSGPA (Std)	−0.116***	−0.118***	−0.115***
	(0.008)	(0.009)	(0.012)
Vocational units (Std)	0.025***	0.019**	0.030***
	(0.005)	(0.008)	(0.007)
SES composite: Q2	0.002	−0.019	0.014
	(0.019)	(0.032)	(0.024)
SES composite: Q3	−0.023	−0.029	−0.021
	(0.019)	(0.031)	(0.023)
SES composite: Q4	−0.090***	−0.101***	−0.084***
	(0.018)	(0.030)	(0.023)
HS enrollment (1000 s)	0.016**	0.008	0.021**
	(0.008)	(0.012)	(0.010)
HS program: college preparatory	−0.047***	−0.050***	−0.047***
	(0.012)	(0.019)	(0.016)
HS program: vocational	−0.016	−0.035	−0.004
	(0.024)	(0.034)	(0.033)
HS: percent free lunch	0.001**	0.001	0.001**
	(0.000)	(0.001)	(0.001)
HS: teacher pay (1000 s)	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
HS type: urban	−0.096***	−0.078***	−0.109***
	(0.017)	(0.026)	(0.024)
HS type: suburban	−0.012	−0.008	−0.013
	(0.015)	(0.022)	(0.019)
N	6830	3070	3770

Treatment effects are reported as marginal effects estimated at the mean of observables characteristics. Omitted categories: female, white, SES-composite Q1, HS General, HS Rural. Dummy variable approach used to address missing data problem and to retain sample size. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

HS high school

*p < .10; **p < 0.05; ***p < 0.01

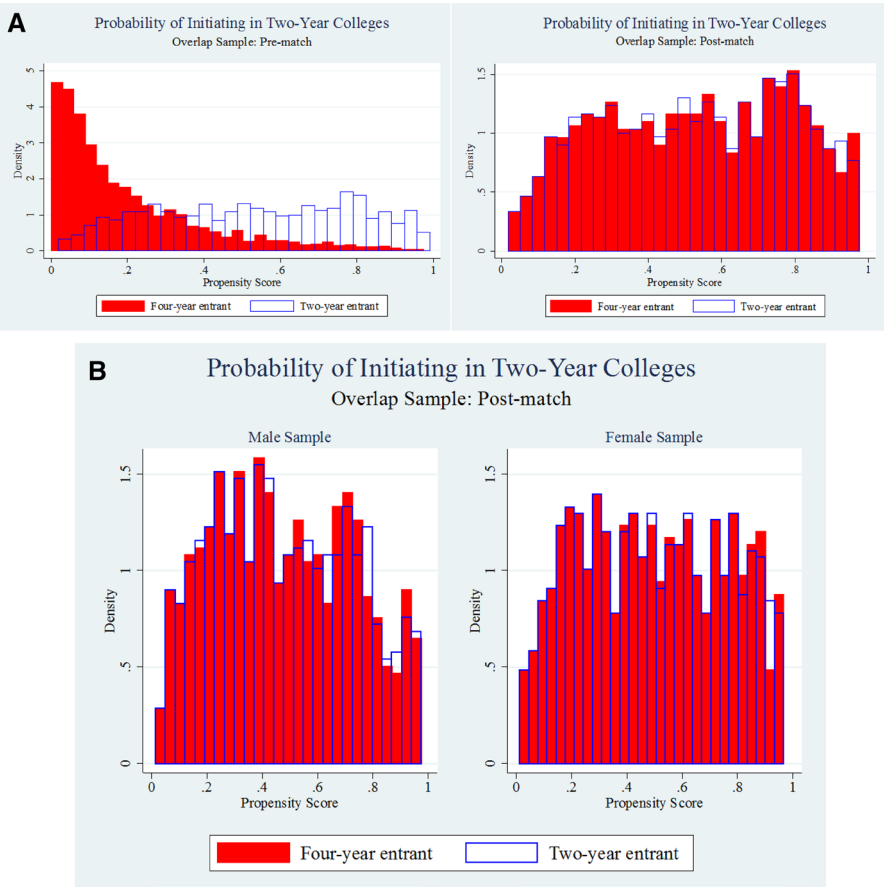

Fig. 1 **a** Distribution of the predicted probability of attending a 2-year college for 2-year and 4-year entrants (Pre-match vs. Post-match). **b** Distribution of the predicted probability of attending a 2-year college for 2-year and 4-year entrants (male and female subsamples)

had a low probability of choosing the 2-year college pathway; about half had a probability equal to 0.10 or lower, and three quarters had a probability equal to 0.25 or lower.

It should be noted that while the majority of 2-year entrants had a match within 0.01 standard deviations of the propensity score in the 4-year entrants group, approximately 1% of the 2-year sample was discarded due to lack of support. The right panel in Fig. 1a shows the probability densities for the 2-year college and 4-year institution entrants after matching. Visually, the matching operations for both groups of students seem to have achieved satisfactory overlap, as the two distributions lie on top of each other almost perfectly. We also depict the overlap between the two groups of students for the male and female sample separately in Fig. 1b and the patterns are fairly similar.

In addition to depicting the common support and matching results, we further checked for satisfactory balance on all covariates statistically. Following Austin (2008), we used the standardized difference (or SD, the absolute difference in sample means divided by an estimate of the pooled standard deviation of the variable, where zero indicates perfect balance) to check balance in group means. Some researchers (e.g., Hill 2008) also recommend

Table 4 Balance between 2-year and 4-year entrants

Variable	Sample	Unmatched sample				Matched sample			
		Mean	Std. dev.	Std. diff.	S-ratio	Mean	Std. dev.	Std. diff.	S-ratio
Male	2-year	0.46	0.50	0.02	1.00	0.46	0.50	0.01	1.00
	4-year	0.45	0.50			0.46	0.50		
White	2-year	0.56	0.5	0.19	1.05	0.57	0.5	0.02	1.00
	4-year	0.66	0.47			0.58	0.49		
Black	2-year	0.13	0.33	0.08	1.10	0.13	0.34	0.05	1.06
	4-year	0.1	0.3			0.11	0.32		
Hispanic	2-year	0.16	0.36	0.22	1.36	0.15	0.36	0.07	0.94
	4-year	0.08	0.27			0.18	0.38		
Asian	2-year	0.1	0.31	0.03	0.96	0.11	0.31	0.04	1.05
	4-year	0.12	0.32			0.09	0.29		
Other	2-year	0.05	0.22	0.01	1.02	0.05	0.22	0.03	1.07
	4-year	0.05	0.21			0.04	0.2		
Reading score G12	2-year	49.85	8.39	0.78	1.02	50.01	8.33	0.03	1.01
	4-year	56.37	8.19			50.22	8.25		
Math score G12	2-year	48.71	8.11	0.94	0.99	48.88	8.02	0.04	1.01
	4-year	56.36	8.2			48.56	7.98		
HSGPA	2-year	2.69	0.58	0.85	1.09	2.71	0.57	0.05	1.03
	4-year	3.18	0.53			2.74	0.55		
Vocational units	2-year	3.25	2.29	0.41	1.20	3.22	2.25	0.021	1.00
	4-year	2.3	1.91			3.27	2.24		
SES composite: Q1	2-year	0.21	0.41	0.28	1.37	0.21	0.41	0.05	1.04
	4-year	0.1	0.3			0.19	0.39		
SES composite: Q2	2-year	0.26	0.44	0.22	1.19	0.26	0.44	0.05	0.97
	4-year	0.16	0.37			0.28	0.45		
SES composite: Q3	2-year	0.29	0.45	0.05	1.03	0.29	0.45	0.01	0.99
	4-year	0.26	0.44			0.29	0.45		
SES composite: Q4	2-year	0.25	0.43	0.54	0.86	0.25	0.43	0.02	1.01
	4-year	0.48	0.5			0.24	0.43		
HS enrollment (1000 s)	2-year	1.33	0.9	0.14	1.17	1.33	0.89	0.003	0.99
	4-year	1.21	0.77			1.32	0.9		
HS program: general	2-year	0.36	0.48	0.28	1.16	0.35	0.48	0.01	1.00
	4-year	0.22	0.41			0.36	0.48		
HS program: college prep	2-year	0.57	0.5	0.35	1.13	0.57	0.49	0.01	1.00
	4-year	0.74	0.44			0.58	0.49		
HS program: vocational	2-year	0.08	0.27	0.14	1.35	0.08	0.27	0.05	1.09
	4-year	0.04	0.2			0.07	0.25		
HS: percent free lunch	2-year	24.8	15.47	0.22	1.26	24.57	15.25	0.03	1.01
	4-year	21.45	12.24			24.96	15.11		
HS: teacher pay (1000 s)	2-year	42.43	8.88	0.05	1.13	42.42	8.89	0.05	1.12
	4-year	42.01	7.88			41.99	7.9		
HS type: rural	2-year	0.29	0.45	0.20	0.93	0.29	0.45	0.01	1.00
	4-year	0.38	0.48			0.29	0.45		

Table 4 (continued)

Variable	Sample	Unmatched sample				Matched sample			
		Mean	Std. dev.	Std. diff.	S-ratio	Mean	Std. dev.	Std. diff.	S-ratio
HS type: urban	2-year	0.53	0.5	0.10	1.00	0.52	0.5	0.02	1.00
	4-year	0.48	0.5			0.51	0.5		
HS type: suburban	2-year	0.19	0.39	0.10	1.10	0.19	0.39	0.02	0.99
	4-year	0.15	0.35			0.19	0.4		

Std. Diff. standardized difference in group means, calculated following the formula by Austin (2008). The S-ratio is the ratio of the standard deviation between the 2-year and 4-year samples, calculated by dividing the higher standard deviation by the standard deviation of the other group

examining higher-order sample balance; therefore, we also checked the ratio of standard deviations between the 2-year college entrants and 4-year institution entrants (the S-ratio, where 1 indicates perfect balance). Results for the balance check are presented in Table 4 and indicate that the matching process resulted in satisfactory balance, reducing most SD values to below 0.10, with S-ratios hovering close to 1.

Results

Impact of 2-Year College Entry on Academic and Labor Market Outcomes

To estimate the impact of 2-year college entry on students' academic and labor market outcomes, we focus on four specific outcome measures: (i) baccalaureate attainment within 6 years of initial college enrollment; (ii) log earnings in 2011, or 7 years after initial enrollment; (iii) employment status in 2012, or 8 years after initial enrollment (full-time employment vs. part-time or unemployed); and (iv) conditional employment status in 2012 (full-time employment vs. part-time employment).

Table 5 presents the estimated effects on these four outcome measures based on five different model specifications: column 1 uses the full analytical sample and provides a raw comparison between the 2-year and 4-year college entrants without any covariates; column 2 uses the same sample but adds controls for baseline differences between the two groups in terms of demographic characteristics, prior academic achievement, and high school characteristics (see Table 1 for a full list); and column 3 shows the estimated impacts based on the post-match sample constructed using Eq. (2). Finally, columns 4 and 5 present post-match results for males and females, respectively.

As shown in Table 5, students who initiated at a 2-year college were significantly less likely to receive a baccalaureate within 6 years and this negative effect is consistent across all five model specifications. However, despite being consistently negative, the magnitude of the estimated effects was smaller in the post-match sample than in the full baccalaureate-seeking sample. Specifically, the raw 44 percentage point difference between 2-year college and 4-year institution entrants in terms of baccalaureate attainment narrowed by half—to 23 points—after we controlled for observable student characteristics (column 2); the difference was further reduced to 19 points after propensity score matching (column 3). Based on the post-match sample, the impact of 2-year college entry on baccalaureate attainment was fairly similar for males and females.

Table 5 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes

	Full Sample		Matched sample		
			All students	Male students	Female students
	(1)	(2)	(3)	(4)	(5)
Received baccalaureate degree or higher	−0.442***	−0.234***	−0.194***	−0.200***	−0.225***
	(0.013)	(0.015)	(0.021)	(0.031)	(0.028)
N	6820	6820	2690	1220	1440
Ln(earnings)	−0.231***	−0.076*	−0.004	0.073	−0.134
	(0.037)	(0.040)	(0.060)	(0.073)	(0.089)
N	5680	5680	2140	960	1160
Employed full-time (vs. PT or unemployed)	−0.057***	−0.018	−0.003	−0.032	−0.063**
	(0.014)	(0.016)	(0.023)	(0.028)	(0.030)
N	5780	5780	2220	1000	1190
Full-time conditional employment (vs. PT)	−0.040***	−0.026*	0.000	−0.041*	0.018
	(0.013)	(0.014)	(0.021)	(0.024)	(0.033)
N	5360	5360	2010	920	1070
Covariates		X	X	X	X

Note Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Regional unemployment rate used as a control for labor market outcomes. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in models 2-5. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

In terms of labor market outcomes, estimates were generally negative, although the estimated negative effects were substantially smaller after controlling for baseline differences between the 2-year college and 4-year institution entrants (column 2). Further, the negative effects were no longer significant in the post-match sample (column 3). The only exception was full-time employment for female students—female students who initiated at a 2-year college were less likely to be employed full-time (versus employed part-time or unemployed), as compared to their 4-year institution counterparts.[9]

Sensitivity Analysis for Unobserved Bias

One possible threat to our estimated association between 2-year entrance and student outcomes is that unmeasured pre-enrollment characteristics might jointly influence both

[9] For all outcome measures, we estimated treatment effects for a restricted sample of students who completed 24 or more credits during college. We do this to assess whether our results are sensitive to a sample of relatively motivated students. 24 credits represent 1-year of full-time course work and serves as an indicator of being "on-track" to earn a degree and/or transfer. Restricting the sample in this way alleviates concerns about whether there are unobservable characteristics such as motivation not captured in our matching strategy. As shown in Appendix Table 9, the results based on the restricted sample are consistent in both magnitude and statistical significance.

college choice and an individual's degree and labor market outcomes. We tested the sensitivity of our estimates to possible unmeasured bias following Rosenbaum's method (2002). Specifically, we used Eq. (3) to determine how strong an unmeasured variable must be to question our conclusion from the matching analysis (Becker and Caliendo 2007; Rosenbaum 2002).

$$\frac{1}{e^{\gamma}} \leq \frac{\mathrm{P}(x_i)\left(1-\mathrm{P}(x_j)\right)}{\mathrm{P}(x_j)\left(1-\mathrm{P}(x_i)\right)} \leq e^{\gamma} \tag{3}$$

Appendix Table 13 presents the results from the sensitivity analysis on the role of selection on unobservables in the completion of a bachelor's degree. The results indicate that the estimates are no longer statistically significant at the 10% level when the relative odds of attending a 2-year college is approximately three (see Reynolds (2012) for the identical procedure and results). That is, to question our conclusion regarding the negative association between 2-year college enrollment and baccalaureate attainment, an unobserved covariate would have to significantly decrease the probability of baccalaureate attainment while tripling the odds of 2-year college enrollment after controlling for all the observable variables.

To further examine the likelihood of such hidden bias, we compared the size of the hidden bias with the odds ratio of all the observable variables used in our matching strategy to predict 2-year college enrollment. Our strongest predictor—moving from the bottom quartile to any other SES-quartile—increases the relative odds of attending a 2-year college by two. These results imply that the estimated association between 2-year college enrollment and baccalaureate attainment is fairly robust against potential unobserved covariates.

Heterogeneous Impacts by Prior Academic Achievement

Thus far, the results suggest that initiating at a 2-year college instead of a 4-year institution has a negative impact on baccalaureate attainment, also negatively influencing females' labor market outcomes. However, the average effects may mask heterogeneous impacts of 2-year college entrance by student academic qualifications. To explore this possibility, we split the student sample into quartiles using SAT Math score. Table 6 reports the results for each subsample.[10]

The results outlined in Table 6 indicate that for both female and male students, the baccalaureate attainment gap (Panel A) tends to be wider for students with higher pre-enrollment math ability. For male students, 2-year college entry reduced baccalaureate attainment by approximately 14 percentage points for the least-prepared male students; the corresponding gap increased to 25 and 21 percentage points for males in quartile 3 and 4 respectively. Similarly, the attainment gap for females increased from 18 percentage points for those in the lowest quartile to 35 percentage points for those in the highest one.

The pattern is less clear with regard to labor market outcomes, partly due to noisier estimates in general, especially for log earnings (Panels B and C). That said, it seems

[10] We include an additional table Appendix Table 12 that shows the interaction between the estimated effects of 2-year college entrance and students' math ability, using the least-prepared students—i.e., those who scored in the lowest math quartile—as the reference group.

Table 6 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes, by student math ability (matched sample)

	Male sample			Female sample		
			N			N
Panel (A) Outcome = Baccalaureate Attainment						
2-year: Math-quartile1	−0.139***	(0.046)	500	−0.180***	(0.043)	640
2-year: Math-quartile2	−0.217***	(0.060)	340	−0.258***	(0.056)	380
2-year: Math-quartile3	−0.249***	(0.071)	200	−0.193***	(0.068)	240
2-year: Math-quartile4	−0.210**	(0.092)	100	−0.348**	(0.140)	90
Panel (B) Outcome = Employed Full-time (vs. PT or unemployed)						
2-year: Math-quartile1	−0.034	(0.042)	390	−0.006	(0.048)	520
2− year: Math-quartile2	−0.032	(0.055)	290	−0.079	(0.049)	310
2-year: Math-quartile3	0.031	(0.079)	180	−0.126**	(0.064)	200
2-year: Math-quartile4	−0.406***	(0.116)	90	−0.115	(0.136)	90
Panel (C) Outcome = Ln(Earnings)						
2-year: Math-quartile1	0.110	(0.130)	380	−0.042	(0.137)	510
2-year: Math-quartile2	−0.018	(0.106)	290	−0.212*	(0.118)	300
2-year: Math-quartile3	0.160	(0.130)	160	−0.078	(0.134)	210
2-year: Math-quartile4	−0.267	(0.209)	80	0.103	(0.253)	90

Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Regional unemployment rate used as a control in models where labor market measures are used as outcome measures. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in all models. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

that the penalty of 2-year entrance on full-time employment status is primarily concentrated among students with higher math ability: male 2-year entrants with the highest math ability (quartile 4) are associated with reduced probability of full-time employment by 41 percentage points compared to their 4-year counterparts. For females, students with math ability in the third quartile are associated with the largest penalty—a reduced probability of full-time employment by 13 percentage points compared to their 4-year counterparts.

Potential Mechanisms for Disparity

Having identified negative impacts of starting in 2-year colleges on students' academic and labor market outcomes, we follow the existing literature in examining four possible mechanisms through which disparities may emerge.

Academic Progress Momentum

Given the extensive literature indicating that enrollment and successful completion of introductory courses in the early stage of students' college career is critical for academic momentum and degree attainment (Adelman 1999, 2006; Attewell et al. 2012, Calcagno et al. 2006), the first mechanism we examined is students' academic progress during their first few terms of college enrollment. Specifically, we constructed four indicators of college credit accumulation during the first 2 years of enrollment, and compared 2-year college entrants and similar 4-year institution entrants in terms of these measures using the post-match baccalaureate-seeking sample: (i) the number of any type of credits attempted, either college-level or remedial in nature, (ii) the number of college-level credits attempted, (iii) the number of any type of credits earned, and (iv) the number of college-level credits earned.[11] If the 2-year college experience indeed dampened students' early academic success, either by influencing students to attempt fewer credits overall or by diverting students into remedial coursework that did not move them toward a degree, we would expect to observe a negative association between 2-year entry and credit accumulation in the early years of students' college career.

The results are presented in Table 7. It seems that the attempted course credit gaps between the two groups are evident as early as the first term. Specifically, the regression-adjusted comparison based on the matched sample (column 7) indicates that students who initiated at a 2-year college attempted slightly fewer credits during their initial term than did their 4-year institution counterparts. Such a credit gap steadily increased over time, implying that the collegiate environment or course enrollment policy at 2-year colleges may encourage students to take on smaller credit loads. By the end of the second year, 4-year institution students attempted 6.5 more credits, on average, than 2-year college entrants—the approximate equivalent of two three-credit courses.

In addition, the divergence in attempted college-level credits is consistently greater than the divergence in total course credits, suggesting that 2-year college students were more likely to be referred to remedial courses than their similar 4-year institution peers even though the two groups were matched on their pre-college academic preparedness. 2-year college students attempted almost 2 fewer college-level credits in their first term than their 4-year institution counterparts; this figure increased to 4 credits by the end of the first year and to 8 credits at the end of the second year. The gap in attempted course credits is also reflected in credit accumulation: by the end of the second year, 2-year college students earned approximately 6 fewer overall credits and 7 fewer college-level credits than similar 4-year institution entrants.

Failure to Transfer

We then explored the transfer patterns of baccalaureate-seeking 2-year college entrants. As shown in Table 8, overall, only about 40% of baccalaureate-seeking 2-year college entrants ever transferred to a 4-year institution. Table 8 further shows that 40% of very successful 2-year college entrants—students who either completed an associate degree or accumulated more than 60 credits from a 2-year college—failed to transfer. Traditionally, students are expected to transfer at the beginning of their third academic year after earning

[11] We use a standardized measure of postsecondary credits attempted and earned.

Table 7 Disparity in early academic progress between matched 2-year and 4-year entrants

	Raw means		Matched sample		Regression adjusted estimates			
	2-year Entrants	4-year Entrants	2-year Entrants	4-year Entrants	Full sample		Matched sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any credits attempted								
First semester	10.64	13.53	10.67	11.83	−1.364***	(0.131)	−1.351***	(0.171)
First year	23.31	29.70	23.37	26.55	−3.729***	(0.356)	−3.208***	(0.484)
First two years	42.67	57.23	42.85	48.83	−7.614***	(0.669)	−6.531***	(0.917)
College credits attempted								
First semester	8.463	12.99	8.53	10.49	−2.377***	(0.144)	−2.211***	(0.187)
First year	19.84	28.83	19.98	24.31	−5.238***	(0.366)	−4.439***	(0.489)
First two years	38.19	56.11	38.51	45.79	−9.400***	(0.678)	−7.940***	(0.927)
Any credits earned								
First semester	8.264	12.28	8.29	9.50	−1.649***	(0.163)	−1.433***	(0.226)
First year	18.22	26.82	18.31	21.24	−4.051***	(0.386)	−3.136***	(0.532)
First two years	33.50	51.67	33.78	39.36	−7.989***	(0.702)	−6.285***	(0.966)
College credits earned								
First semester	6.824	11.90	6.87	8.70	−2.343***	(0.160)	−2.076***	(0.214)
First year	15.96	26.22	16.12	19.96	−5.082***	(0.382)	−4.111***	(0.515)
First two years	30.71	50.92	31.06	37.71	−9.194***	(0.695)	−7.420***	(0.937)
N		6610		2560		6610		2600

Column 5 and 7 include full set of controls listed in Table 1. Firsterm fixed effects included in columns 5 and 7. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

Table 8 Transfer patterns among 2-year college baccalaureate-seeking students

Outcome	Count	%	n
Transfer rate			
All baccalaureate-seeking 2-year entrants	640	39	1630
Associate earners	230	58	390
Diploma or certificate earners (no associate degree)	10	27	40
No community college award	400	34	1200
College-level credits earned from 2-year colleges			
< 20	140	23	620
20–39	100	36	290
40–59	120	52	230
> 60	290	53	530
Timing of transfer (among vertical transfers, n = 650)			
1st academic year	70	10	
2nd academic year	110	17	
3rd academic year	170	26	
4th academic year	120	18	
5th academic year	60	9	
6th academic year	50	7	
7th academic year	40	6	
8th academic year or beyond	40	7	
College-level credits earned upon transfer (among vertical transfers)			
< 20	140	22	
20–39	100	16	
40–59	120	18	
> 60	280	44	

Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

approximately 60 credits at the home institution. However, when we examined the timing of transfer, we found that very few students followed such a pattern and that there were striking variations in students' transfer trajectories. For example, only a quarter of students transferred during their first or second year, and almost 50% transferred four or more years after entry. Similarly, vertical transfer students varied widely in regard to the number of college-level credits accrued at the time of transfer, with credit totals ranging from 0 to 144 college-level credits, a mean of 49 credits, a median of 54 credits, and a large standard deviation of 30 credits. These patterns seem to suggest that there is no well-trodden, highly-structured transfer pathway for students to follow. Instead, 2-year college students seem to be left to discover their own idiosyncratic path to a 4-year institution. Still more worrisome is the fact that roughly 35% of students transferred with more than 65 credits, implying that students may be required to take more credits than needed in order to transfer to a 4-year institution.

Loss of Credits During Transfer

As mentioned earlier, one key barrier to academic success for vertical transfer students may be a loss of credits at the time of transfer. A loss of credits at transfer means students may

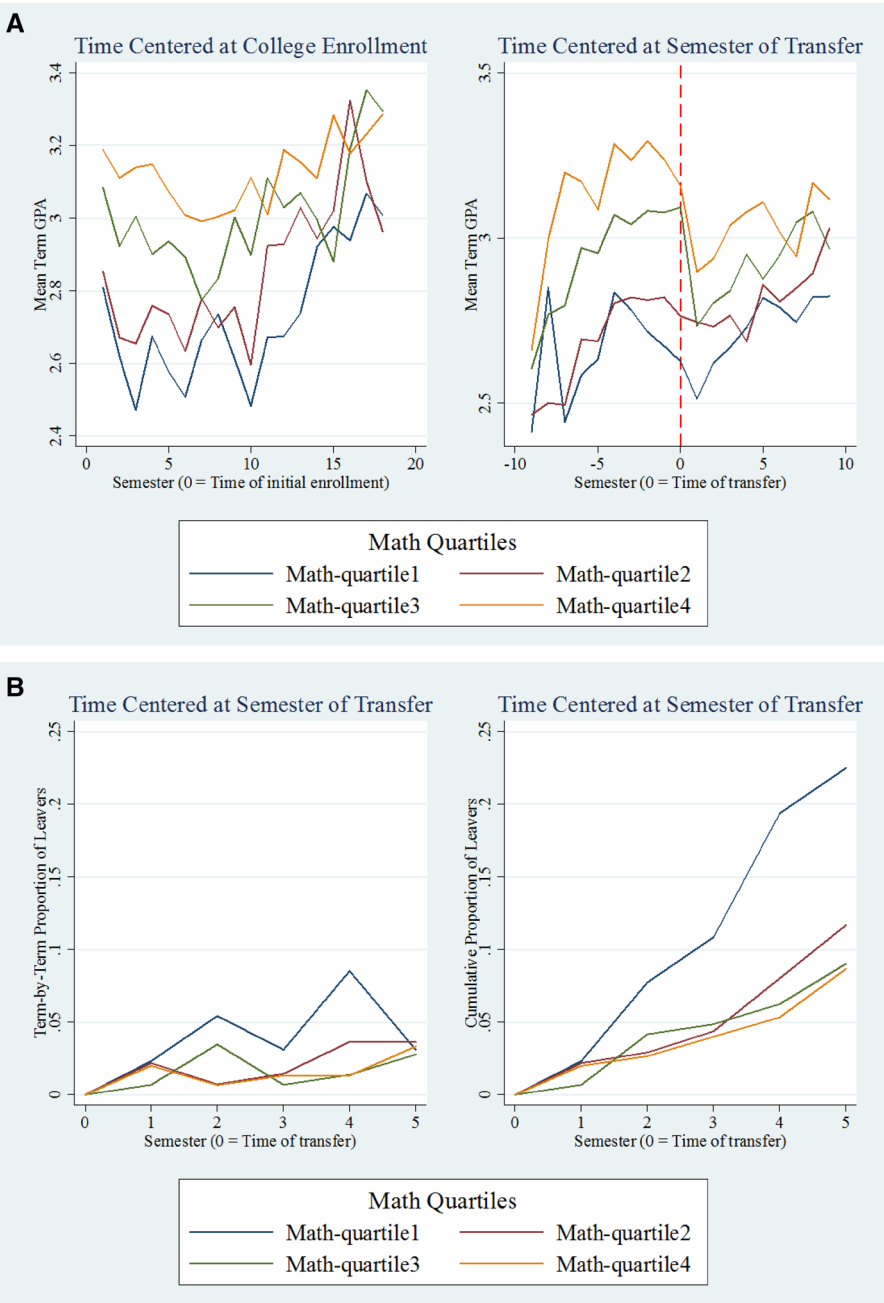

Fig. 2 **a** Term-by-term fluctuations in GPA among vertical transfers. **b** Term-by-term fluctuations in the proportion of leavers among vertical transfers

take longer to earn a baccalaureate—a scenario that could contribute to dropout, especially in cases where students do not have the financial means to stay at the destination institution for more than 2 years. Indeed, the vertical transfer students in our sample (n = 650) lost 15 credits (equivalent to five three-unit courses), on average, at the time of transfer. In addition, the large standard deviation of the number of credits lost during transfer (sd = 23 credits) suggests that the extent of credit loss during the transfer process may vary substantially across institutions.

Post-transfer Academic Shock

Finally, we examined the possibility that students may be subject to post-transfer shock due to adjustment to the new collegiate environment at the destination college. Figure 2a presents the term-by-term changes in transfer students' GPA; the right panel is centered at the time of transfer (i.e., time = 0 is the last term at the 2-year home institution). Students are plotted by prior math ability (using the four quartiles described in Sect. 4.3). On average, transfer students experienced a noticeable decline in GPA in the term following their arrival at the destination institution, and such a drop was present for students in all four ability groups. However, the average vertical transfer student's GPA quickly rebounded after the first term. This GPA dip and subsequent rebound may be driven by two separate trends. First, the GPA dip may be due to transfer students' social and logistical adjustment to the new institution's environment, and GPA may gradually recover after students integrate into the destination institution socially and academically. Another possible source of the GPA rebound may be changes in the demographic mix of students over time. For example, if weaker students in our sample were more likely to drop out after their first term at the 4-year destination institution, the stronger students would more heavily influence GPA patterns afterwards.

To shed light on these two explanations, we conducted two additional analyses: the first one replicated Fig. 2a but restricted the sample to transfer students who remained in the destination institution beyond the first year. Similar patterns of GPA dip and partial rebound in later terms were also observed for this restricted sample, providing evidence for the first explanation. Additionally, we also directly explored the term-by-term post-transfer dropout rate after transfer students arrived at the destination institution, based on students' math ability. The pattern presented in Fig. 2b suggests that only a small proportion of students left the destination institution by the end of the first term: the dropout rate by the end of the first term is most pronounced for students in the lowest quartile, but even for this group, only 2.4% of students left after their first term.

Discussion & Conclusion

Concomitant with the surge in tuition and fees associated with higher education attendance, 2-year colleges have increasingly come to serve as the starting point for many baccalaureate-aspiring students—especially students from lower income and minority groups. In this paper, we contribute to the literature about the transfer function of 2-year colleges by estimating the impacts of initiating at a 2-year college regarding students' probability of attaining a baccalaureate as well as their short-term labor market performance. Using a propensity score matching strategy put forth by previous researchers in this field, we found that the 2-year college pathway substantially reduces students' likelihood of earning a baccalaureate. In addition, our analysis indicates that female 2-year college entrants are less likely to be employed full-time as compared to similar 4-year entrant peers 8 years after initial college enrollment.

Our examination of possible mechanisms driving such disparity suggests that 2-year college policies tend to depress students' college-level credit accrual, which may be due in large part to the common policy of 2-year colleges to place students in lengthy remedial sequences from which few emerge (Bailey et al. 2010). In addition, we found that 2-year college students took on fewer credits than their matched 4-year institution peers. This may be partly due to the flexible course enrollment policy at 2-year colleges that enables its large adult learner population to maintain lower credit loads in order to balance academic work with employment or family responsibilities (Klempin 2014). In our sample, disparity in credit accumulation is evident as early as the initial semester of enrollment, with gaps of 1.3 credits, on average; this figure increases to 3.2 credits by the end of the first academic year. By the end of the second academic year, 2-year college entrants earned 6 fewer credits and 7 fewer college-level credits, on average, than their 4-year institution counterparts; these figures are the equivalent of two three-credit courses.

Overall, only about one-third of the baccalaureate-aspiring 2-year college entrants in our sample ever made it to the 4-year sector. Even very successful 2-year college students often failed to transfer, and for the students who did transfer, idiosyncratic patterns and timing of transfer seem to suggest that they had no clearly structured transfer pathway to follow. In addition, we found that vertical transfer students were subject to credit loss during the transfer process. Moreover, the fact that vertical transfer students typically experienced a decline in GPA at the point of transfer, later compensated for, suggests that transfer students may have difficulty adjusting to the destination institution after transfer.

These findings echo many recent studies contending that 2-year college transfer pathways are insufficiently structured and supported (e.g., Bailey et al. 2015; Baker 2015; Jaggars and Fletcher 2014; Scott-Clayton 2011; Xu et al. 2018). The majority of these studies have used administrative data from one or several institutions within a state; our study extends these analyses in using nationally representative data. As states and colleges search for new strategies with which to increase transfer rates and the success of transfer students, our results suggest that the responsibility should not rest solely with 2-year colleges; instead, transfer destinations must also form partnerships with 2-year colleges to build strong transfer pathways and provide support for transfer students' success.

As explicitly indicated by Castleman et al. (2015), highly structured programs limit student confusion and ensure transfer students face fewer obstacles. To build these institutional supports, 4-year transfer destinations may need to work with key feeder 2-year colleges to create agreements specifying that students who earn a transfer-oriented associate degree in a given field are guaranteed junior-level standing in a matching major at the 4-year institution (Baker 2015). Policies such as this may have a salutary effect on credit loss. Indeed, studies representing three different public college systems have found that vertical transfer students who earn transfer-oriented associate degrees have higher rates of baccalaureate attainment than do similar vocationally-oriented associate degree holders or non-degree holders even after controlling for the number of credits accumulated before transfer (Crook et al. 2012; Crosta and Kopko 2014; Ehrenberg and Smith 2004). In addition, given that academic support is positively associated with transfer student retention (Lee and Schneider 2016), transfer destinations may need to orient, advise, and provide support services to transfer students in order to facilitate their academic and social integration into the destination institution (Wyner et al. 2016).

We also assessed whether the average negative effect of 2-year college entry on student academic and labor market outcomes varies according to students' pre-college level of academic ability. For both academic and labor market outcomes, we found evidence suggesting that the negative effects are particularly strong for students with higher levels

of math achievement. This echoes the findings in Brand et al. (2012), as the 2-year college pathway to a baccalaureate was found to have the largest penalty for more-academically-advantaged students. The specific reason why high ability students are associated with the largest decrement in degree attainment is beyond the scope of the present study, but one possibility may be that the most likely counterfactual for these academically advantaged students is selective or highly selective 4-year institutions where transfer students are often regarded as low priority for admission (Wyner et al. 2016).

In addition, existing literature has identified a strong association between students' math ability and probability of choosing a STEM major (Chen 2009; Wang 2013). However, a handful of studies indicate that the transfer process can be particularly challenging for students interested in pursuing STEM majors for several reasons (Wang et al. 2015; Jaggars et al. 2016; Lyon and Denner 2016). First, STEM programs tend to have specific course requirements students must satisfy prior to transfer. However, these courses may not be available at local 2-year colleges, therefore prompting students to commute to a nearby 4-year institution to fulfill them (Wyner et al. 2016; Jaggars et al. 2016; Lyon and Denner 2016). This could be particularly challenging for students enrolled at 2-year colleges in rural areas that do not have adjacent 4-year institutions. In addition, due to the high demand for STEM education, STEM programs are generally more selective than non-STEM programs and have limited capacity. As a result, transfer students often are low-priority in terms of admission into these majors (Wyner et al. 2016). Finally, different from the small classes and collaborative environment of departments at 2-year institutions, STEM programs at 4-year institutions tend to have large student enrollment and a competitive culture, which may present challenges for the social and academic integration of new students. Future research that has access to information about the specific fields of study students intend to pursue may wish to explore potential heterogeneity in the transfer processes of different majors.

Finally, it is worth noting that our study spans the Great Recession which may have influenced the labor market returns to college, both in general and for subgroups of individuals. For example, the employment of young workers declined by 12% between 2007 and 2009. The job loss and unemployment rates were sharper in male-dominated fields, such as construction and manufacturing, where the employment rates decreased by 19% and 13% respectively during the same period of time (Mulligan, 2012). As a result, existing research has consistently found that men experienced significantly larger job loss in the Great Recession compared to women (Hoynes et al. 2012; Taylor et al. 2011). Thus, even though all groups may suffer during the recession, the payoff to a college degree may be more compressed for males than females. Indeed, using administrative data from the State of Ohio, Minaya and Scott-Clayton (2017) examined returns to terminal associate degrees and certificates during the economic recession. They identified higher payoffs to a community college credential for women than men in terms of both quarterly earnings and stability of employment. Our results are broadly consistent with those in Minaya and Scott-Clayton (2017), in that initiating at a 4-year institution is associated with higher payoffs in terms of full-time employment for females than males. However, the same caveat stated in Minaya and Scott-Clayton (2017) applies to our study: the differential impacts of 2-year college entry on labor market outcomes for males and females may be partly due to variations in the impacts of the recession on male-dominated and female-dominated occupations.

Additionally, we were able to observe students' earnings for only 7 years, which may not be long enough to capture the full labor market effects of initiating at a 2-year versus 4-year institution. Indeed, approximately 6.5% of our sample's vertical transfer

students and 4.5% of the matched native 4-year institution students were still enrolled in college by the end of our tracking period, and many of these students may eventually earn a baccalaureate. Even among students who earned their baccalaureate during the time period under study, most did so only a few years before the end of the study. Prior research examining college students' earnings trajectories indicates that the bulk of positive returns for baccalaureates are due not to immediate increases in earnings levels, but instead to acceleration in students' earnings growth over time (Jaggars and Xu 2016). If we measured earnings further into the future, we might find that some students reach an earnings plateau—for students who did not graduate or who earned only a certificate, for example—while those with a baccalaureate may experience sharp increases in earnings over time. Accordingly, future studies may wish to employ a longer follow-up window in order to shed light on the impact of 2-year college entrance on students' labor market performance in the long run.

Acknowledgements The research reported here was supported by the American Educational Research Association, through Grant 78089 to University of California, Irvine. The opinions expressed are those of the authors and do not represent views of the American Educational Research Association. Any errors are our own.

Appendix

See Tables 9, 10, 11, 12 and 13.

Table 9 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes (restricted sample)

	Full sample		Matched sample
	(1)	(2)	(3)
Received baccalaureate degree or higher	−0.424***	−0.249***	−0.187***
	(0.015)	(0.017)	(0.023)
N	6040	6040	2070
Ln(earnings)	−0.245***	−0.108**	−0.044
	(0.042)	(0.045)	(0.060)
N	5110	5110	1730
Employed full-time (vs. PT or unemployed)	−0.060***	−0.024	−0.029
	(0.016)	(0.017)	(0.025)
N	5180	5180	1740
Full-time conditional employment (vs. PT)	−0.045***	−0.032**	−0.032
	(0.014)	(0.015)	(0.020)
N	4830	4830	1620
Covariates		X	X

Sample restricted to students who earned 24 college-level credits during their college career. Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Regional unemployment rate used as a control in models where labor market measures are used as outcome measures. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in models 2 & 3. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

Table 10 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes (including dual enrollment students)

	Full sample		Matched sample
	(1)	(2)	(3)
Received baccalaureate degree or higher	−0.421***	−0.220***	−0.183***
	(0.013)	(0.015)	(0.020)
N	6970	6970	2880
Ln(earnings)	−0.209***	−0.059	−0.017
	(0.035)	(0.038)	(0.064)
N	5800	5800	2280
Employed full-time (vs. PT or unemployed)	−0.055***	−0.017	−0.017
	(0.014)	(0.015)	(0.022)
N	5910	5910	2360
Full-time conditional employment (vs. PT)	−0.037***	−0.023*	−0.040**
	(0.012)	(0.013)	(0.017)
N	5480	5480	2180
Covariates		X	X

Sample includes students who earned college credits prior to their first-term in college (dual enrollment students). Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Regional unemployment rate used as a control in models where labor market measures are used as outcome measures. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in models 2 & 3. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

Table 11 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes (using region of residence fixed effects)

	Full sample		Matched sample		
			All students	Male students	Female students
	(1)	(2)	(3)	(4)	(5)
Received baccalaureate degree or higher	−0.442***	−0.234***	−0.194***	−0.200***	−0.225***
	(0.013)	(0.015)	(0.021)	(0.031)	(0.028)
N	6820	6820	2690	1220	1440
Ln(earnings)	−0.228***	−0.074*	−0.065	0.033	−0.084
	(0.037)	(0.040)	(0.064)	(0.081)	(0.096)
N	5680	5680	2150	960	1160
Employed full-time (vs. PT or unemployed)	−0.058***	−0.017	−0.012	0.009	−0.033
	(0.014)	(0.016)	(0.023)	(0.032)	(0.031)
N	5780	5780	2250	1000	1190
Full-time conditional employment (vs. PT)	−0.040***	−0.026*	−0.012	−0.046*	−0.042
	(0.013)	(0.014)	(0.021)	(0.024)	(0.027)

Table 11 (continued)

	Full sample		Matched sample		
			All students	Male students	Female students
	(1)	(2)	(3)	(4)	(5)
N	5360	5360	2010	920	1070
Covariates		X	X	X	X

Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Region fixed effects used as a control in models where labor market measures are used as outcome measures. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in models 2–5. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

Table 12 Impact of initiating in a 2-year college on student baccalaureate attainment and labor market outcomes, by student math ability (matched sample)

	Baccalaureate attainment		Employed full-time (vs. PT or unemployed)		Ln(Earnings)	
	Male sample	Female sample	Male sample	Female sample	Male sample	Female sample
	(1)	(2)	(5)	(6)	(7)	(8)
2-year	−0.139***	−0.180***	−0.034	−0.006	0.110	−0.042
	(0.046)	(0.043)	(0.043)	(0.049)	(0.135)	(0.142)
2-year*Math-quartile2	−0.078	−0.077	0.001	−0.073	−0.128	−0.169
	(0.077)	(0.071)	(0.071)	(0.070)	(0.173)	(0.186)
2-year*Math-quartile3	−0.110	−0.012	0.065	−0.120	0.050	−0.036
	(0.084)	(0.079)	(0.088)	(0.079)	(0.184)	(0.193)
2-year*Math-quartile4	−0.072	−0.167	−0.372***	−0.108	−0.377*	0.145
	(0.091)	(0.124)	(0.102)	(0.123)	(0.217)	(0.248)
N	1140	1350	942	1130	910	1100

Continuous outcomes were estimated using ordinary least squares (OLS) regression and binary outcomes were estimated using linear probability models. First-term fixed effects included in all models. Regional unemployment rate used as a control in models where labor market measures are used as outcome measures. Sampling weights used in all models. Dummy variable approach used to address missing data problem and to retain sample size. Full set of controls listed in Table 1 used in all models. Robust standard errors used. Sample sizes rounded to nearest 10 following NCES/IES reporting guidelines

*p < .10; **p < 0.05; ***p < 0.01

Table 13 Sensitivity analysis for unobserved heterogeneity

	Effect	$e^{\gamma}=1$	$e^{\gamma}=1.5$	$e^{\gamma}=2$	$e^{\gamma}=2.5$	$e^{\gamma}=3$
Men	−0.206***	9.32 (0.00)	5.96 (0.00)	3.63 (0.00)	1.84 (0.03)	0.39 (0.35)
Women	−0.198***	10.48 (0.00)	6.83 (0.00)	4.29 (0.00)	2.34 (0.01)	0.76 (0.22)

e^{γ} measures the degree of departure from an estimation that is free from hidden bias. Each column includes the Mantel–Haenszel test statistic and the corresponding p value

*p < .10; **p < 0.05; ***p < 0.01

References

Abadie, A., Angrist, J., & Imbens, G. (2002). Instrumental variables estimates of the effect of subsidized training on the quantiles of trainee earnings. *Econometrica, 70*(1), 91–117.

Adelman, C. (1999). Answers in the tool box. Academic intensity, attendance patterns, and bachelor's degree attainment. *National Inst. on Postsecondary Education, Libraries, and Lifelong Learning (ED/OERI)*.

Adelman, C. (2006). The toolbox revisited: Paths to degree completion from high school through college. *US Department of Education*.

Alfonso, M. (2006). The impact of community college attendance on baccalaureate attainment. *Research in Higher Education, 47*(8), 873–903.

Allison, (2002). *Missing data*. Thousand Oaks: Sage Publications.

Anderson, K. L. (1981). Post-high school experiences and college attrition. *Sociology of Education, 54,* 1–15.

Attewell, P., Heil, S., & Reisel, L. (2012). What is academic momentum?And does it matter? *Educational Evaluation and Policy Analysis, 34*(1), 27–44.

Austin, P. C. (2008). Assessing balance in measured baseline covariates when using many-to-one matching on the propensity-score. *Pharmacoepidemiology and Drug Safety, 17*(12), 1218–1225.

Bahr, P. R., Toth, C., Thirolf, K., & Massé, J. C. (2013). A review and critique of the literature on community college students' transition processes and outcomes in four-year institutions. In *Higher Education: Handbook of theory and research* (pp. 459–511). Springer, Dordrecht.

Bailey, T. R., Jaggars, S. S., & Jenkins, D. (2015). *Redesigning America's community colleges*. Cambridge: Harvard University Press.

Bailey, T., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review, 29*(2), 255–270.

Baker, R. B. (2015). *Understanding and Affecting Students' Path to Success in Community Colleges* (Doctoral dissertation, Stanford University).

Baker, R. (2016). The effects of structured transfer pathways in community colleges. *Educational Evaluation and Policy Analysis, 38*(4), 626–646.

Becker, S. O., & Caliendo, M. (2007). Sensitivity analysis for average treatment effects. *The Stata Journal, 7*(1), 71–83.

Berkner, L., & Choy, S. (2008). Descriptive summary of 2003-04 beginning postsecondary students: three years later. NCES 2008-174. *National Center for Education Statistics*.

Brand, J. E. (2010). Civic returns to higher education: A note on heterogeneous effects. *Social Forces, 89*(2), 417–434.

Brand, J. E., Pfeffer, F. T., & Goldrick-Rab, S. (2012). *Interpreting community college effects in the presence of heterogeneity and complex counterfactuals*. Los Angeles: California Center for Population Research, University of California, Los Angeles.

Brand, J. E., & Xie, Y. (2010). Who benefits most from college? Evidence for negative selection in heterogeneous economic returns to higher education. *American Sociological Review, 75*(2), 273–302.

Brint, S. (2003). Few remaining dreams: Community colleges since 1985. *The Annals of the American Academy of Political and Social Science, 586*(1), 16–37.

Brown, Z., & Xia, X. (2014). *Attending a four-year college directly or transferring from a* 2-year *college: Does the path to a bachelor's degree matter?* (Working Paper). Paper presented at the Association for Education Finance and Policy annual conference, San Antonio, TX.

Calcagno, J. C., Crosta, P., Bailey, T., & Jenkins, D. (2006). Stepping stones to a degree: The impact of enrollment pathways and milestones on older community college student outcomes. CCRC Brief Number 32. *Community College Research Center, Columbia University*.

Calcagno, J. C., & Long, B. T. (2008). The impact of postsecondary remediation using a regression discontinuity approach: Addressing endogenous sorting and noncompliance (No. w14194). *National Bureau of Economic Research*.

Castleman, B. L., Schwartz, S., & Baum, S. (2015). The shapeless river: Does a lack of structure inhibit students' progress at community colleges?. In *Decision Making for Student Success* (pp. 114–135). Routledge.

Chen, X. (2009). Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education. *Stats in Brief*. NCES 2009-161. National Center for Education Statistics.

Choy, S. P., & Gifford, A. G. (1990). Profile of undergraduates in American postsecondary institutions. *Survey Report*.

Clark, B. A. (1960). The "cooling-out" function in higher education. *American Journal of Sociology, 65,* 569–576.

Crook, D., Chellman, C. C., & Holod, A. (2012). Does earning an associate degree lead to better baccalaureate outcomes for transfer students. *City University of New York, Office of Policy Research.* Retrieved from http://www.cuny.edu/about/administration/offices/ira/opr/papers/associate_degree.Pdf.

Crosta, P. M., & Kopko, E. M. (2014). Should community college students earn an associate degree before transferring to a four-year institution. *Community College Research Center Working Paper*, *No.* 70.

Dehejia, R. H., & Wahba, S. (2002). Propensity score-matching methods for nonexperimental causal studies. *Review of Economics and Statistics, 84*(1), 151–161.

Desrochers, D. M., & Hurlburt, S. (2014). Trends in college spending: 2001–2011. A delta data Update. *Delta Cost Project at American Institutes for Research*.

Domingo, M. S., & Nouri, H. (2016). How do transfer students in accounting compare academically to" native" students? *Global Perspectives on Accounting Education, 13,* 21.

Dougherty, K. J. (1994). *The contradictory college: The conflicting origins, impacts, and futures of the community college*. Albany, NY: SUNY Press.

Doyle, W. R. (2009). Impact of increased academic intensity on transfer rates: An application of matching estimators to student-unit record data. *Research in Higher Education, 50*(1), 52–72.

Education Longitudinal Study of 2002 (n.d.). Retrieved March 22, 2018, from https://nces.ed.gov/surveys/els2002/.

Ehrenberg, R. G., & Smith, C. L. (2004). Analyzing the success of student transitions from 2-to 4-year institutions within a state. *Economics of Education Review, 23*(1), 11–28.

Flaga, C. T. (2006). The process of transition for community college transfer students. *Community College Journal of Research and Practice, 30*(1), 3–19.

Gallagher, R. P. (2010). *National survey of counseling center directors.* Retrieved from http://www.iacsinc.org/NSCCD%202010.pdf.

Grubb, W. N. (2006). Vocationalism and the differentiation of tertiary education: Lessons from US community colleges. *Journal of Further and Higher Education, 30*(1), 27–42.

Hill, J. (2008). Discussion of research using propensity-score matching: Comments on 'A critical appraisal of propensity-score matching in the medical literature between 1996 and 2003'by Peter Austin. *Statistics in Medicine. Statistics in Medicine, 27*(12), 2055–2061.

Hills, J. R. (1965). Transfer shock: The academic performance of the junior college transfer. *The Journal of Experimental Education, 33*(3), 201–215.

Hilmer, M. J. (2000). Does the return to university quality differ for transfer students and direct attendees? *Economics of Education Review, 19*(1), 47–61.

Hoynes, H., Miller, D. L., & Schaller, J. (2012). Who suffers during recessions? *Journal of Economic Perspectives, 26*(3), 27–48.

Hull, J. A. (2018). *Exploring the impact of the associate degree on bachelor's degree completion for reverse transfer eligible students using propensity score matching* (Doctoral dissertation, Rowan University).

Jackson, D. L., & Laanan, F. S. (2015). Desiring to fit: Fostering the success of community college transfer students in STEM. *Community College Journal of Research and Practice, 39*(2), 132–149.

Jaggars, S., Fink, J., & Fletcher, J. (2016). *A longitudinal analysis of community college pathways to computer science bachelor's degrees*. New York: Community College Research Center, Teachers College, Columbia University.

Jaggars, S., & Fletcher, J. (2014). *Redesigning the student intake and information provision processes at a large comprehensive community college*. New York: Community College Research Center, Teachers College, Columbia University.

Jaggars, S. S., & Xu, D. (2016). Examining the earnings trajectories of community college students using a piecewise growth curve modeling approach. *Journal of Research on Educational Effectiveness, 9*(3), 445–471.

Jenkins, P. D., & Fink, J. (2015). *What we know about transfer*. New York: Community College Research Center, Teachers College, Columbia University.

Jenkins, D., & Fink, J. (2016). *Tracking transfer: New measures of institutional and state effectiveness in helping community college students attain bachelor's degrees*. New York: Community College Research Center, Teachers College, Columbia University.

Kadlec, A., & Gupta, J. (2014). Indiana regional transfer study: The student experience of transfer pathways between ivy tech community college and Indiana University. *Public Agenda*.

Kadlec, A., & Martinez, M. (2013). Putting it all together: Strengthening pathways between comprehensives and community colleges. *American Enterprise Institute private convening*, "Comprehending Comprehensives," Washington, DC.

Kane, T. J., & Rouse, C. E. (1995). Labor-market returns to two-and four-year college. *The American Economic Review, 85*(3), 600–614.

Klempin, S. (2014). *Redefining full-time in college: Evidence on 15-credit strategies*. New York: Community College Research Center, Columbia University.
Lakin, J. M., & Elliott, D. C. (2016). STEMing the shock: Examining transfer shock and its impact on STEM major and enrollment persistence. *Journal of The First-Year Experience & Students in Transition, 28*(2), 9–31.
Lee, H., & Schneider, T. (2016). Does posttransfer involvement matter for persistence of community college transfer students? *Community College Journal of Research and Practice, 42*(2), 77–94.
Leigh, D. E., & Gill, A. M. (2003). Do community colleges really divert students from earning bachelor's degrees? *Economics of Education Review, 22*(1), 23–30.
Light, A., & Strayer, W. (2004). Who receives the college wage premium? Assessing the labor market returns to degrees and college transfer patterns. *Journal of Human Resources, 39*(3), 746–773.
Long, B. T., & Kurlaender, M. (2009). Do community colleges provide a viable pathway to a baccalaureate degree? *Educational Evaluation and Policy Analysis, 31*(1), 30–53.
Lundberg, C. A., Kim, Y. K., Andrade, L. M., & Bahner, D. T. (2018). High expectations, strong support: Faculty behaviors predicting Latina/o community college student learning. *Journal of College Student Development, 59*(1), 55–70.
Lyon, L. A. & Denner, J. (2016). *Student perspectives of community college pathways to computer science bachelor's degrees*. Mountain View, CA: Google Inc. Retrieved from https://goo.gl/Q0wJJv.
Martorell, P., & McFarlin, I., Jr. (2011). Help or hindrance? The effects of college remediation on academic and labor market outcomes. *The Review of Economics and Statistics, 93*(2), 436–454.
Miller, T. E. (2007). Will they stay or will they go? Predicting the risk of attrition at a large public university. *College and University, 83*(2), 2.
Minaya, V., & Scott-Clayton, J. (2017). Labor market trajectories for community college graduates: new evidence spanning the great recession. A CAPSEE Working Paper. *Center for Analysis of Postsecondary Education and Employment*.
Monaghan, D. B., & Attewell, P. (2015). The community college route to the bachelor's degree. *Educational Evaluation and Policy Analysis, 37*(1), 70–91.
Mulligan, C. B. (2012). *The redistribution recession: How labor market distortions contracted the economy*. New York, NY: Oxford University Press.
Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students* (Vol. 1991). San Francisco: Jossey-Bass.
Public Agenda Foundation WestEd (Organization). (2012). *Student voices on the higher education pathway: Preliminary insights and stakeholder engagement considerations*.
Reynolds, C. L. (2012). Where to attend? Estimating the effects of beginning college at a 2-year institution. *Economics of Education Review, 31*(4), 345–362.
Rosenbaum, P. R. (2002). *Observational studies* (2nd ed.). New York: Springer.
Rosenbaum, J. E., Deil-Amen, R., & Person, A. E. (2006). *After admission: From college access to college success*. New York, NY: Russell Sage Foundation Press.
Rosenbaum, P. R., & Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician, 39*(1), 33–38.
Rouse, C. E. (1995). Democratization or diversion? The effect of community colleges on educational attainment. *Journal of Business & Economic Statistics, 13*(2), 217–224.
Rubin, D. B., & Thomas, N. (2000). Combining propensity score matching with additional adjustments for prognostic covariates. *Journal of the American Statistical Association, 95*(450), 573–585.
Scott-Clayton, J. (2011). On money and motivation a quasi-experimental analysis of financial incentives for college achievement. *Journal of Human Resources, 46*(3), 614–646.
Scott-Clayton, J., & Rodriguez, O. (2015). Development, discouragement, or diversion? New evidence on the effects of college remediation policy. *Education Finance and Policy, 10*(1), 4–45.
Shapiro, D., Dundar, A., Huie, F., Wakhungu, P. K., Yuan, X., Nathan, A., & Hwang, Y. (2017). Tracking transfer: Measures of effectiveness in helping community college students to complete bachelor's degrees. *Signature Report No.* 13.
Stephan, J. L., Rosenbaum, J. E., & Person, A. E. (2009). Stratification in college entry and completion. *Social Science Research, 38*(3), 572–593.
Taylor, P., Kochhar, D. R., Dockterman, D., & Motel, S. (2011). In two years of economic recovery, women lost jobs, men found them. *Pew Research Center.*
Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89–125.
Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. University of Chicago Press, 5801 S. Ellis Avenue, Chicago, IL 60637.

Townsend, B. K., & Wilson, K. (2006). " A hand hold for a little bit": Factors facilitating the success of community college transfer students to a large research university. *Journal of College Student Development, 47*(4), 439–456.

Velez, W. (1985). Finishing college: The effects of college type. *Sociology of Education, 58,* 191–200.

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081.

Wang, X., Chan, H. Y., Phelps, L. A., & Washbon, J. I. (2015). Fuel for success: Academic momentum as a mediator between dual enrollment and educational outcomes of 2-year technical college students. *Community College Review, 43*(2), 165–190.

Wyner, J., Deane, K. C., Jenkins, D., & Fink, J. (2016). *The transfer playbook: Essential practices for two- and 4-year colleges*. New York: Aspen Institute.

Xu, D. (2016). Assistance or obstacle? The impact of different levels of english developmental education on underprepared students in community colleges. *Educational Researcher, 45*(9), 496–507.

Xu, D., & Dadgar, M. (2018). How effective are community college remedial math courses for students with the lowest math skills? *Community College Review, 46*(1), 62–81.

Xu, D., Jaggars, S. S., Fletcher, J., & Fink, J. E. (2018). Are community college transfer students "a good bet" for 4-year admissions? Comparing academic and labor-market outcomes between transfer and native 4-year college students. *The Journal of Higher Education, 89*(4), 478–502.